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Semiconductor arrangement

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Because of different coefficients of expansion of the materials lying contiguous to one another in surface-to-surface contact between semiconductor bodies, especially when large areas are involved, problems often arise when the bodies are subjected to alternating thermal stresses. These problems occur mainly in voltage semiconductor assemblies, for example, in power transistors and voltage rectifiers. The expansion coefficients of silicon, and the contact metals in question, such as tungsten or molybdenum, and the support metals, such as copper or silver, as well as the metals occasionally used for housings, such as iron and brass, differ considerably from one another, so that alternating thermal stress may lead to damage or even the destruction of a semiconductor element made up of these materials.

Prior art contains various proposals for the elimination of the above mentioned problems. For example, the use for silicon rectifiers of support plates that are made of a tungsten, molybdenum, or chromium sintered structure that is filled with a highly conductive metal has become known. With this approach a relatively good adaptation to the thermal expansion coefficients of the semiconductor body is reached, but not to those of the connecting parts of the support plate, for example, to those of a housing, if it happens to be made of copper or silver.

The object of the invention is a semiconductor assembly, in which alternating thermal stresses occur and in which a metal sintered plate is provided between the semiconductor body and each related collecting electrode. In accordance with the invention the above mentioned problems are practically completely eliminated by the fact that the sintered plates are made of a metal or a metal alloy that has a plastic ductility that is at least equal to that of a copper-silver alloy. In an embodiment of the invention the sintered plates connect directly to the semiconductor body and are directly soft soldered to it. The invention has very advantageous effects in the case of silicon rectifiers.

Copper or silver powder or an appropriate alloy powder, for example, one made of (1) the above mentioned elements as the base metal and (2) plasticizing metal additives, such as nickel, is especially suitable as the start-up powder for sintered plates.

Based on the structural design of the sintered plates envisioned by the invention, the different expansion

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coefficients of the contiguously lying semiconductor and support materials are by-passed by an "accordion effect" and deterioration of the characteristics of the semiconductor assembly, for example, those of the rectifier, that is caused by developing mechanical distortions is avoided to a great degree. This is important, especially because the elasticity range of semiconductors is relatively small. To this must be added the following factual situation:

As is generally known elastic changes in the shape of a body that occur within Hooke's range are reversible; such changes are proportional to the magnitude of the applied mechanical stress. If one measures certain electrical values in a semiconductor system with adequate accuracy, one will nevertheless discover permanent changes even within Hooke's range. These may occur, for example, because of shifts in the concentration and in the locational distribution of grid flaws (offsets). Added to this is the fact that as the alternating thermal stresses increase, e.g., during alternating on/off operation, the soft solder coating is also damaged by the mechanical stresses that arise. Thus, e.g., in a prior art silicon rectifier, several hundred alternations between 100°C and room temperature may be enough to lead to considerable damage or even total failure of the rectifier.

The above listed events are prevented by the porous sintered plates envisioned by the invention. This is attributable to the fact that the sintered plates compensate for developing mechanical stresses by means of plastic deformations in the microscopic ranges. It is especially important that the sintered plates maintain their plastic properties even after a great number of temperature

changes, i.e., that they essentially show no symptoms of fatigue.

Please refer to the drawing for a further explanation of the invention.

Figure 1 shows schematically the structure of a rectifier.

Figure 2 shows the installation of a rectifier of the type shown in figure 1 in housing.,

Figure 3 shows an additional exemplary embodiment of a rectifier.

In figure 1 a sintered plate is designated by the number **1**; it may, for example, be produced from copper powder and have a porosity level of 0.20, a spacer plate of molybdenum by the number **2**, the copper support by the number **3**, the semiconductor body by the number **4**, and an additional sintered plate by the number **5**, which may, for example, be produced from copper powder and have a porosity level of 0.16. The sintered plate **5** is soft soldered to the semiconductor body; while the other parts may be hard soldered. The pn-junction of the semiconductor body may be manufactured in the conventional way, for example, in the case of a silicon semiconductor body by the alloying process, using A1 and Au-Sb or Au-B and Au-Sb.

The support designated by a 3 in figure 1 may, for example, also be designed as a housing as shown in figure 2. The sintered plate **5** is connected to a flexible lead-in wire, which is designated by the number **6**. The connections to the power source are designated by the number **7**. The remaining designating numbers have the same meaning as in figure 1. This also applies to figure 3, in which the sintered plate **5** is designed to be connected directly to the flexible lead-in wire **6**.

The porous sintered plates may be directly soft soldered to the semiconductor body in semiconductors that have relatively small surfaces. In such cases it is advisable that a higher level of porosity be selected, possibly between 0.25 and 0.50.

To be added to the above-mentioned advantages of the subject sintered plates is the fact that these sintered plates have a significantly better electrical and thermal conductivity than the support plates made of tungsten, molybdenum, or a chromium sintered structure with excellent conductive metal fillers that were mentioned earlier and that were proposed in the past

.Consequently and above all, better heat dissipation and a lower equilibrium temperature are achieved.

Patent Claims:

1. A semiconductor assembly, in which alternating thermal stresses occur and in which a metal sintered plate is provided between the semiconductor body and each related collecting electrode, characterized by the fact that the sintered plates are made of a metal or a metal alloy that has a plastic ductility that is at least equal to that of a copper-silver alloy.
2. Semiconductor assembly according to claim 1, characterized by the fact that the sintered plates are directly soft soldered to the semiconductor body.
3. Semiconductor assembly according to claim 1, characterized by the fact that a spacer plate is provided on at least one side of the semiconductor body between the semiconductor body and the sintered plate, whose expansion coefficient is adapted to that of the semiconductor body.
4. Semiconductor assembly according to one of the claims 1 through 3 characterized by the fact that it is designed as a rectifier.
5. Semiconductor assembly according to one of the claims 1 through 4, characterized by the fact that the semiconductor body is made of silicon.
6. Process for manufacturing a semiconductor assembly according to one of the claims 1 through 5, characterized by the fact that copper or silver powder or an alloy powder is used as the starting material for the sintered plates.

Literature used as reference:
Austrian Patent Specification No. 190 593.

Attached hereto is one sheet of drawings

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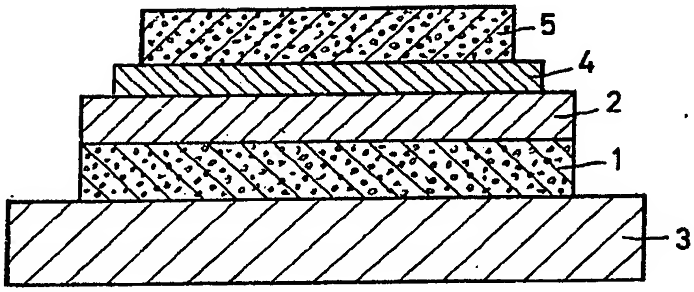

Figure 1

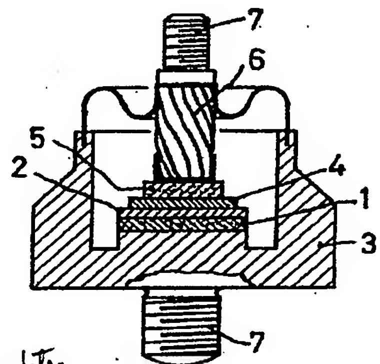

Figure 2

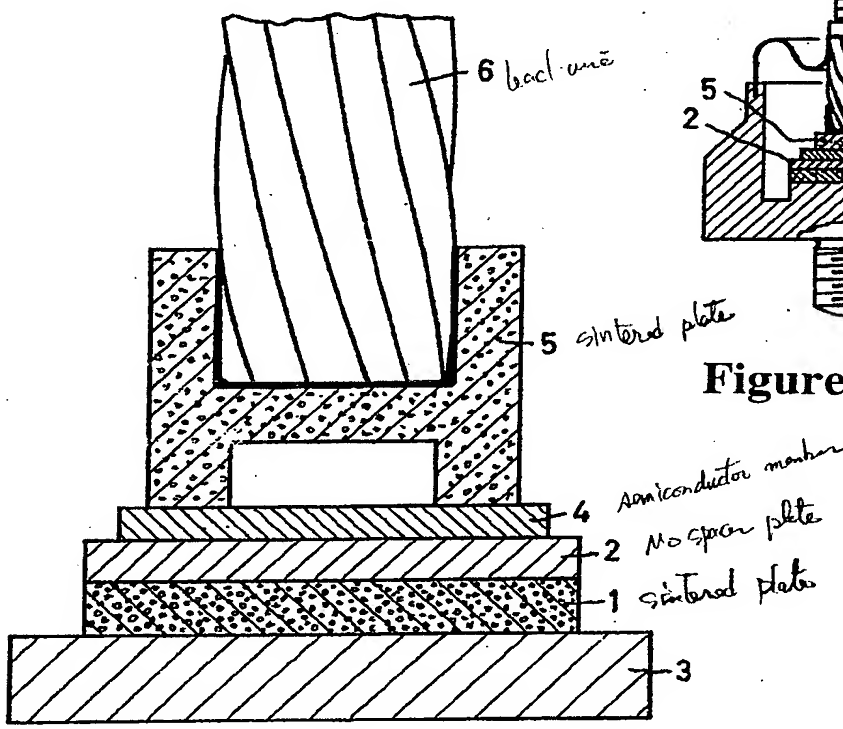

Figure 3